

**WE CLAIM:**

1. A process for preparation of nutritionally upgraded oilseed meals, which are protein and lipid-rich and have a reduced fibre content, and plant oils from oilseeds suitable for use in fish or other non-human animal diets or human foods comprising the steps of:

- providing a source of oilseed;
- subjecting said oilseed to heat treatment to substantially reduce the concentration of at least some antinutritional components normally present in said oilseed to obtain heat-treated seed;
- dehulling said heat-treated seed to produce a meat fraction, a hull fraction or a mixture thereof; and
- cold pressing said meat fraction or said mixture to yield said plant oils and said protein and lipid-rich meals .

2. A process for preparation of nutritionally upgraded oilseed meals, which are protein and lipid-rich and have a reduced fibre content, and plant oils from oilseeds for use in fish or other non-human animal diets or human foods comprising the steps of:

- providing a source of oilseed;
- subjecting said oilseed to heat treatment to substantially reduce the concentration of at least some antinutritional components normally present in said oilseed to obtain heat-treated particulate seed;
- providing a source of unhydrolyzed animal offal;
- blending said heat-treated seed in particulate form with said animal offal, and if required water together with an antioxidant, to form a mixture thereof;
- cooking said mixture under conditions selected to substantially improve protein digestibility, and substantially free cellular water present in said animal offal, as well as to facilitate separation of protein from the lipid in said animal offal and said oilseeds to obtain a cooked mixture; and

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- separating said cooked mixture into a stickwater fraction, a moisture containing protein-rich fraction, and an animal feed grade oil fraction.

3. A process according to claim 1, for the preparation of protein concentrates and lipid sources from co-processing of animal offal with oilseed for use in fish or other non-human animal feeds, wherein the cold pressing step of said oilseed fraction is carried out so as to substantially reduce the particle size of said oilseed fraction to yield a high value human grade oil and protein and lipid-rich meals with reduced fibre content; said process comprising the further steps of:

- providing a source of unhydrolyzed animal offal;
- blending said protein and lipid-rich meal with said animal offal, and if required water together with an antioxidant, to form a blended mixture thereof;
- cooking said blended mixture under conditions selected to substantially improve protein digestibility, and substantially free cellular water present in said animal offal, as well as to facilitate separation of protein from the lipid in said animal offal and said oilseeds to obtain a cooked mixture; and
- separating said cooked mixture into a stickwater fraction, a moisture containing protein-rich fraction, and an animal feed grade oil fraction.

4. A process for preparation of protein concentrates and lipid sources from co-processing of animal offal with oilseeds for use in fish or other non-human animal diets comprising the steps of:

- providing a source of oilseed;
- cold pressing said oilseed under conditions to substantially reduce particle size of said oilseed and obtain pressed raw seeds;
- providing a source of unhydrolyzed animal offal;
- blending said pressed raw seeds with said animal offal, and if required water together with an antioxidant, to produce a mixture thereof;
- cooking said mixture under conditions to substantially improve protein

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digestibility, and substantially free cellular water present in said animal offal and facilitate separation of protein from the lipid in said animal offal and said oilseed to obtain a cooked mixture; and

- separating said cooked mixture into a stickwater fraction, a moisture containing protein-rich fraction, and an animal feed grade oil fraction.

5. A process as defined in claim 4, for preparation of protein concentrates and lipid sources from the co-processing of animal offal with oilseeds for use in fish or other non-human animal diets comprising the steps of:

- providing a source of oilseed;
- drying said oilseed to produce a dried seed;
- dehulling said dried seed to produce a meat fraction, a hull fraction or a mixture thereof;
- cold pressing said oilseed meat fraction under conditions selected to substantially reduce particle size of said meat or mixture to yield a high value human grade oil and protein and lipid-rich meals with reduced fibre content;
- providing a source of unhydrolyzed animal offal;
- blending said protein and lipid-rich meals with said animal offal to form a blended mixture thereof;
- cooking said blended mixture under conditions selected to substantially improve protein digestibility, substantially free cellular water present in said animal offal and facilitate separation of protein from the lipid in said animal offal and said oilseeds to obtain a cooked mixture; and
- separating said cooked mixture into a stickwater fraction, a moisture containing protein-rich fraction, and an animal feed grade oil fraction.

6. A process for producing a protein concentrate for use in animal and aquafeeds comprising the steps of:

- providing a source of oilseed;
- drying said oilseed to reduce its moisture content to below about 10%

to obtain a dried seed or subjecting said oilseed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce a heat-treated seed;

- cold pressing or grinding said dried seed or heat-treated seed to reduce the particle size and yield human grade oil;
- providing a source of unhydrolyzed animal offal;
- blending said oilseed and said animal offal in a ratio of about 10:90 to about 90:10, and if required in the presence of water and an antioxidant, to form a mixture thereof;
- cooking said mixture to obtain a cooked mixture prior to said extracting step.
- separating said cooked mixture into a stickwater fraction, a moisture containing protein-rich fraction, and an animal feed grade oil fraction.
- extracting said mixture with a solvent; and
- removing said solvent to obtain a protein concentrate.

7. The process according to claim 1, further including the step of extracting said protein and lipid-rich meals with a solvent.
8. The process according to claim 1, further including the step of stabilizing said plant oils by adding an antioxidant.
9. The process according to claim 2, further including the step of drying said protein-rich fraction to reduce its moisture content to below about 10%.
10. The process according to claim 2, wherein said heat treatment is a rapid heat treatment.
11. The process according to claim 2, wherein said oilseed is selected from the group consisting of canola, rape seed, soybeans, sunflower seed, flax seed,

mustard seed, cotton seed, hemp and mixtures thereof.

12. The process according to claim 1, wherein said oilseed is selected from the group consisting of canola, sunflower seed, flax seed, mustard seed, and mixtures thereof.
13. The process according to claim 2, wherein said animal offal is selected from the group consisting of fish processing waste, whole fish, fish by-catch, squid offal, whole birds without feathers, beef offal, poultry offal, lamb offal and mixtures thereof.
14. The process according to claim 2, wherein said oilseed and said animal offal are mixed together in a ratio of about 10:90 to about 90:10 by weight.
15. A protein source for use in animal and aquafeeds comprising an animal product selected from animal offal, whole fish too small for filleting operations, fish by-catch and whole birds with or without feathers in an amount of about 22% to about 90% by weight; and
  - oilseed in an amount of about 10% to about 78% by weight; and
  - wherein said animal product and said oilseed have been co-processed and cooked together, following which fluids have been removed therefrom to obtain a pressed mixture which has been dried to provide said protein source.
16. A protein source as defined in claim 15, said source having from about 40% to about 80% protein calculated on a lipid-free dry weight basis, said source comprising an admixture of treated oilseed protein and animal offal whereby said admixture is characterized by at least one of the following:
  - enriched concentrations of essential amino acids and bio-available minerals relative to those present in said animal offal or untreated oilseed;

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- enriched concentrations of highly unsaturated n-3 fatty acids relative to those present initially in said oilseed if said source of animal offal is fish;
- reduced concentrations of heat-labile and water soluble antinutritional factors in an amount of at least 20% by weight relative to non-treated oilseed protein;
- increased protein digestibility relative to non-treated oilseed protein; and
- a lipid concentration of less than 10% of dry weight of said source.

17. The protein source according to claim 16, wherein said reduction of the heat-labile and antinutritional factors is at least 80% calculated on a lipid-free dry weight basis.
18. The protein source according to claim 16, wherein said oilseed is selected from canola, rape seed, soybeans, sunflower seed, flax seed, mustard seed, cotton seed, hemp and mixtures thereof.
19. The protein source according to claim 16, wherein said animal offal is selected from whole fish, fish processing waste, fish by-catch, squid offal, whole birds without feathers, beef offal, poultry offal, lamb offal and mixtures thereof.
20. The protein source according to claim 16, having a protein content of about 50% to about 77% calculated on a lipid-free dry weight basis and a lipid content of less than about 10% by weight.
21. An edible organic oil comprising an oilseed oil, said organic oil having been obtained by cold pressing oilseed in which the cold pressing was carried out at temperatures below 85°C, said oil having minimal lipid oxidation products and a peroxide value of less than about 2 milliequivalents per kg following oilseed processing.

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22. The organic oil according to claim 21, wherein said oilseed is selected from canola, sunflower seed, flax seed, mustard seed and mixtures thereof.
23. An animal feed grade oil for use in animal and aquafeeds comprising an admixture of lipids from treated oilseed oil and animal offal, said admixture having an enriched n-3 highly unsaturated fatty acid content ( $20:5n-3 + 22:6n-3$ ) relative to non treated oilseed oil if fish is said source of animal offal.
24. The animal feed grade oil according to claim 23, wherein said oilseed is canola and further comprising an enriched monounsaturated fatty acid content ( $18:1 n-9$ ) relative to the non-treated animal offal lipid.
25. A constituent for an organic fertilizer comprising at least one of canola, sunflower, soybean, mustard seed, cotton seed and hemp hulls, said hulls being dried or heat treated hulls and containing protein and lipid.
26. Condensed solubles for use as constituents in organic fertilizers comprising soluble compounds derived from the processing of an admixture of treated oilseed and animal offal whereby said solubles have an enriched soluble nitrogen content, water soluble carbohydrate content, water soluble or heat-labile antinutritional component content and mineral content.
27. The solubles according to claim 26, wherein said oilseed is selected from canola, rape seed, soybeans, sunflower seed, flax seed, mustard seed, cotton seed, hemp and mixtures thereof.
28. The solubles according to claim 26, wherein said animal offal is selected from fish processing waste, whole fish, fish by-catch, squid offal, whole birds without feathers, beef offal, poultry offal, lamb offal and mixtures thereof.
29. A protein and lipid-rich oilseed meal suitable for use in fish and non-human

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animal diets comprising a heat-treated dehulled oilseed, said oilseed being substantially free of flaxseed, mustard seed, rapeseed and cotton seed, said meal having:

- from about 26% to about 40% protein on a dry weight basis;
- from about 48% to about 64% protein on a lipid-free dry weight basis;
- from about 2.4% to about 4.6% methionine and cystine calculated as a percent of said protein;
- from about 3.6% to about 6.1% lysine calculated as a percent of said protein;
- from about 21% to about 52% lipid on a dry weight basis;
- from about 2% to about 12% crude fibre on a lipid-free dry weight basis;
- from about 0.16% to about 0.45% calcium on a lipid-free dry weight basis; and
- less than about 0.01% sodium on a lipid-free dry weight basis.

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30. The meal according to claim 29, further comprising at least one of glucosinolates, sinapine, chlorogenic acid and mixtures thereof.
31. The meal according to claim 30, wherein said glucosinolates are in an amount of up to about 20  $\mu$ moles of total glucosinolates per gram on a lipid-free dry weight basis.
32. A protein concentrate containing an admixture of a co-processed oilseed and unhydrolyzed animal offal, said concentrate being suitable for use in fish and non-human animal diets, said oilseed comprising a heat-treated dehulled oilseed substantially free of flaxseed, mustard seed, rapeseed and cotton seed, said protein concentrate having:
- from about 38% to about 58% protein on a dry weight basis;
  - from about 52% to about 77% protein on a lipid-free dry weight basis;
  - from about 2.7% to about 4.6% methionine and cystine calculated as a percent of protein;

- from about 4.3% to about 7.9% lysine calculated as a percent of said protein;
- from about 24% to about 37% lipid on a dry weight basis;
- from about 1.7% to about 10% crude fibre on a lipid-free dry weight basis;
- from about 0.7% to about 3.6% calcium on a lipid-free dry weight basis;
- and
- from about 0.06% to about 0.30% sodium on a lipid-free dry weight basis.

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33. The protein concentrate according to claim 32, wherein said glucosinolates are in an amount of up to about 4.0  $\mu$ moles of total glucosinolates per gram on a lipid-free dry weight basis.
34. An animal grade oil comprising oil derived from an admixture of a co-processed oilseed and unhydrolyzed animal offal, said oil being substantially free of flaxseed oil, mustard seed oil, rapeseed oil, and cotton seed oil, said animal grade oil having:
- from about 60% to about 92% of total fatty acids as unsaturated fatty acids;
  - from about 8% to about 50% of total fatty acids as (n-6) fatty acids;
  - from about 0.5% to about 35% of total fatty acids as (n-3) fatty acids;
  - from about 3% to about 25% of total fatty acids as n-3 highly unsaturated fatty acids if said source of animal offal is fish; and
  - a peroxide value less than about 8 milliequivalents per kg of oil at the time of production.
35. An edible organic oil comprised of cold pressed heat-treated oilseed, said oil being substantially free of flaxseed oil, mustard seed oil, rapeseed oil and cotton seed oil, said organic oil comprising:
- from about 86% to about 96% of total fatty acids as unsaturated fatty

acids;

- from about 20% to about 80% of total fatty acids as (n-6) fatty acids; and
- a peroxide value of less than about 2 milliequivalents of peroxide per kg oil at the time of production.

36. A process for preparation of oilseed protein concentrates from oilseed for use in fish or other non-human animal diets comprising the steps of:

- subjecting said oilseed to heat treatment under conditions selected to substantially deactivate, destroy or reduce the concentration of at least some of the antinutritional components normally present in oilseed to produce heat-treated seed;
- dehulling said heat-treated seed to produce a meat fraction and a hull fraction;
- cold pressing said meat fraction to yield a high value human grade oil and a moisture containing protein and lipid-rich meal having a reduced fibre content;
- blending said protein and lipid-rich meal with water and an antioxidant to produce a blended mixture;
- cooking said blended mixture under conditions selected to substantially improve protein digestibility to obtain a cooked mixture; and
- separating said cooked mixture into a stick water fraction, a moisture containing protein-rich fraction, and an oil fraction.

37. A process for preparation of oilseed protein concentrates from oilseed for use in fish or other non-human animal diets comprising the steps of:

- drying said oilseed to produce dried seed;
- dehulling said dried seed to produce a meat fraction and a hull fraction;
- cold pressing said meat fraction to yield a high value human grade oil and a moisture containing protein and lipid-rich meal having a reduced fibre content;
- blending said protein and lipid-rich meal with water and an antioxidant

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to produce a blended mixture;

- cooking said blended mixture under conditions selected to substantially improve protein digestibility to obtain a cooked mixture; and
- separating said cooked mixture into a stick water fraction, a moisture containing protein-rich fraction, and an oil fraction.

38. The process according to claim 37, further comprising the steps of subjecting said protein and lipid-rich meal to enzymatic pH adjusted water treatment under conditions selected to substantially decrease the phytic acid concentration normally present in oilseed to produce a protein and lipid-rich meal having reduced phytic acid and fibre contents.
39. The process according to claim 36, further comprising the step of effecting a delay prior to subjecting said blended mixture to said cooking step.
40. An oilseed protein concentrate for use in fish or other animal diets as defined in claim 32, containing from about 50% to about 78% protein and from about 7% to about 12% lipid.
41. A protein and lipid-rich oilseed meal for use in fish or other non-human animal diets as defined in claim 29, containing from about 30% to about 33% protein and about 30% to about 38% lipid.